REMARKS

Claims 9-11 are currently active.

Respectfully, the applicant suggests that the Examiner is missing the most important point which is addressed below.

Tapering is the key feature which controls one of the most important properties of a ceramic to ceramic joint, namely, joint thickness and hence joint strength.

Examining the above-identified patent application reveals by numerical referencing and by reproducing the text the following facts:

Page 2, line 28 through page 3, line 2. "The **thickness** of the preceramic polymer will determine the **strength** of the **joint** as well. Therefore, tight tolerances are normally held in the joint components and even surface roughness can affect the effectiveness of the joint. Heavy machining and mirror polished **flats** are made to **reduce** the **thickness** of the joint material to create a **strong joint**."

The above text ties together joint strength and with thin joints.

Page 4, lines 14-16 in the above-identified patent application states, "Combinations of silicon carbide bodies **10** joined by this technique require only a *close fit* with a **thin layer of the slurry 12** between them."

The lines above emphasize the need for a thin joint.

Page 6, lines 17-24 of the above-identified patent application states, "The inclusion of capture **tapers (FIG. 2)** in the creation of the joint facilitates **stronger joints** by allowing the application of an appropriately **thin coating of slurry 12**. As shown in **FIG. 5**, where the angle of the interior body is inclined at a lesser angle than the exterior body, the slurry **12** is filled between the bodies **10**. There exists a region of **optimal thickness** where the slurry **12** is polymerized in an **optimal manner**."

Finally, tapers are associated with achieving strong joints by making thin joints.

These facts are not obvious to JP 6-256067 and DiChiara, Jr. 6,494,979 and Barton et al. 6,214,472, nor are they suggested or implied.

The Examiner has rejected Claims 9-11 as being unpatentable over JP6-256067 in view of DiChiara. Applicant submits that the most important point is tapering.

Tapering does increase the joining surface area over, for example, a butt-joint geometry. It is also true that, the more joining surface area the greater the strength for a fixed joint thickness. However, increasing the joining area to increase strength **is not the main purpose in tapering** as will be presented in great detail.

If the objective was to simply increase the joining area then a lap-joint would be utilized since it can achieve a much larger joining area than a taper-joint. A lap-joint can be accomplished by inserting one ceramic tube (with a smaller outside diameter (O.D.)) inside another ceramic tube (with a larger inside diameter (I.D.)).

Now a real world example will be presented: let's suppose one needs a sintered silicon carbide (SiC) tube 12 meters long, but one knows they are manufacturing limited to about 6 meters (m). Furthermore, suppose that the desired tube inside diameter is about 11 millimeters (mm). One purchases two 6 m long by 11 mm I.D. by 14 mm O.D. SiC tubes and one purchases one more SiC tube that is 6 m long by 15 mm I.D. by 18 mm O.D. One butts together the two 11 mm I.D. tubes and applies the appropriate joining slurry over 3 m in opposite directions from the butt-joint, covering the entire circumference of each tube. Now, one slips over the O.D. of the two tubes and center (lengthwise) the 15 mm I.D. tube. Now one has a lap-joint that is 3 m long as measured from the butt-joint. The joining area for the butt-joint is 0.589 cm^2 and the joining area for the lap-joint is 1,319.5 cm^2 giving an area

increase of about 2,240 for the lap-joint. If an inside and outside taper is machined (diamond wheel ground) into one end of each of the 6 m long by 11 mm I.D. SiC tubes at a (difficult to achieve) taper angle of 1 degree then the joining area is about 33.75 cm^2 or about 57 times larger than the butt-joint but 66 times smaller than the lap-joint.

This extreme example suggests that a lap-joint would be the most desirable joining method for making strong joints.

However, achieving a reproducible uniform small joint thickness is more difficult with a lap-joint than a taper-joint. To achieve strong joints with pre-ceramic type polymers requires the joint thickness to be less than or comparable to machining equipment limits.

Pre-ceramic polymers work by decomposing at elevated temperatures releasing volatiles and leaving the native joining material. An example is AHPCS decomposing leaving SiC and releasing hydrogen. The downside with this idea is that in order for the pre-ceramic polymer to work, that is yield SiC, the joining material must shrink when it releases volatiles. This shrinkage by volume can be as high as 85% depending on the specific pre-ceramic polymer, additives and the specific heating schedule. When the joint material shrinks it becomes porous and stressing to the joint thus resulting in a weak joint. Making very thin

joints may still have the same percentage shrinkage but the absolute value will be smaller, thus less stress and smaller pores means stronger joints. There are no pre-ceramic polymers with zero shrinkage otherwise it is just a ceramic in a macroscopic solid state not a pre-ceramic in the liquid atomic state. Tens of percent shrinkage is achievable and a joint of 10 microns can barely be machined for a lap joint. By contrast, machining a taper-joint with a taper angle of 3-5 degrees (which is reproducible and can easily be accomplished) the joint thickness can easily be set from zero to submicron thickness simply by controlling the insertion distance. If ceramic or metal powders are added to the pre-ceramic polymer (to reduce shrinkage) then the powder particle diameter will determine the minimum joint thickness. These powders should be in the micron to submicron range in order to achieve strong joints. **In summary, tapering to increase joining area is not very important, however, tapering to control joint thickness is extremely important to achieve joint strength.** After all, it is only important to achieve joint strengths comparable to the as received ceramic.

The DiChiara, Jr.- patent # 6,494,979 is for bonding only oxide ceramics (Datura Jr., column 2, lines 21, 27, 29-31, 39, 40, 43, 46, 48, 52 and column 8 lines 36-64). There is no mention of controlling joint thickness by tapering. There is only interest in mitering to increase the bonding area which as stated above in not important. Therefore, this patent is not relevant to the claims of the above-identified patent application, since they

involve different materials and most importantly do not use tapering to control joint thickness in their claims.

In the patent by Shimpo- patent # JP 6-256067, only the development of a joining compound is addressed with no regard to the joint geometry. In particular, controlling joint thickness using tapering is not addressed. In JP 6-256067 there is no information regarding joint design and nothing specifically on what is a suitable taper.

DiChiara's joining technology combined with Shimpo's joining materials without regard to a teaching for controlling joint thickness has essentially no chance of working. This patent clearly has no relevance to the claims of the above-identified patent application.

The Examiner has rejected Claim 9 as being unpatentable over Barton et al. in view of DiChiara, Jr.

Barton et al. patent # 6,214,472 does not disclose a way to control joint thickness. In particular, there is no mention of using a taper for controlling joint thickness. In view of what has been stated previously, this patent has no relevance to the claims of the above-identified patent application.

Accordingly, Claim 9 is patentable over the applied art of record.

In view of the foregoing remarks, it is respectfully requested that the outstanding rejections and objections to this application be reconsidered and withdrawn, and Claims 9-11, now in this application be allowed.

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